CLAIMS AMENDMENTS

Please amend claims 1 and 62. Please add new claims 36 and 96, which effectively reinstate with some amendment, earlier versions of these same-numbered claims that were cancelled in applicants' July 19, 2005 reply. All other claims are unchanged.

1. (currently amended) A system for identifying and measuring concentrations of elements in fluids, comprising:

an ionic preconcentration cell, comprising:

an upper high surface area electrode comprising a high specific surface area thereof;

a lower high surface area electrode comprising a high specific surface area thereof, substantially parallel to said upper high surface area electrode;

a central flow interelectrode gap separating said upper and lower high surface area electrodes by a predetermined interelectrode gap width; and

fluid flow means for flowing a fluid through said central flow interelectrode gap; ~~and~~

a computerized apparatus comprising calibration data related to a rate at which photons are detected to be emitted from said preconcentration cell based on a fluid of interest containing a known concentration of at least one element of interest being flowed at a known flow rate through said central flow interelectrode gap for a known period of time, a known voltage differential being applied across said electrodes, and said preconcentration cell being exposed to x-rays; and

said computerized apparatus deducing an identity, or

measurement of concentration, of an unknown concentration of said at least one element of interest in said fluid of interest, based on comparing said calibration data with test data related to a rate at which photons are detected to be emitted from said preconcentration cell based on said fluid of interest with said unknown concentration being flowed at a known flow rate through said central flow interelectrode gap for a known period of time, a known voltage differential being applied across said electrodes, and said preconcentration cell being exposed to x-rays.

~~calibration data comprising background data related to a rate at which photons are detected to be emitted from at least one background data energy channel of said preconcentration cell or an equivalent cell, when said preconcentration cell or equivalent cell is filled with a highly purified form of a fluid of interest and exposed to x-rays.~~

2. (original) The system of claim 1, further comprising:

voltage application means for applying a voltage differential between said upper high surface area electrode and said lower high surface area electrode while said fluid is flowing through said central flow interelectrode gap.

3. (previously presented) The system of claim 2, said voltage application means further comprising:

a transportable voltage supply connected across said upper and lower high surface area electrodes for applying an electrostatic charge across said electrodes and thereby maintaining ions from said at least one element entrained in said

electrodes during transport of said ionic preconcentration cell.

4. (previously presented) The system of claim 1, said ionic preconcentration cell further comprising:

an upper x-ray transmission window in intimate contact with an upper surface of said upper high surface area electrode.

5. (previously presented) The system of claim 4, said ionic preconcentration cell further comprising:

a lower x-ray transmission window in intimate contact with a lower surface of said lower high surface area electrode.

6. (original) The system of claim 1, said ionic preconcentration cell further comprising:

inlet flow means for entering a fluid into said ionic preconcentration cell and enabling said fluid to flow through said central flow interelectrode gap.

7. (previously presented) The system of claim 6, said inlet flow means comprising at least one planar inlet flow slot substantially coplanar with said central flow interelectrode gap.

8. (previously presented) The system of claim 6, said inlet flow means comprising a plurality of mutually-substantially coplanar inlet flow tubes substantially coplanar with said central flow interelectrode gap and substantially parallel with one another.

9. (previously presented) The system of claim 6, said inlet flow means comprising turbulence enhancement means for enhancing a turbulence of the flow of said fluid to induce mixing of said flow to enable uniform extraction of said at least one element from the flow stream.

10. (previously presented) The system of claim 6, said inlet flow means comprising access means for accessing said inlet flow means for physically cleaning debris therefrom.

11. (original) The system of claim 1, said ionic preconcentration cell further comprising:

outlet flow means for exiting said fluid out from said ionic preconcentration cell after said fluid has flowed through said central flow interelectrode gap.

12. (previously presented) The system of claim 11, said outlet flow means comprising at least one outlet flow slot substantially coplanar with said central flow interelectrode gap.

13. (previously presented) The system of claim 11, said outlet flow means comprising a plurality of outlet flow tubes substantially coplanar with said central flow interelectrode gap and substantially parallel with one another.

14. (previously presented) The system of claim 11, said outlet flow means comprising access means for accessing said outlet flow means for physically cleaning debris therefrom.

15. (previously presented) The system of claim 4, said ionic preconcentration cell further comprising:

a cell collector body maintaining a position of said upper and lower high surface area electrodes and said upper x-ray transmission window relative to one another, said cell collector body in turn comprising a material comprising:

substantially no conductivity;

resistance to ionic leaching; and

resistance to radiation degradation from x-rays to

which said preconcentration cell is to be exposed.

16. (previously presented) The system of claim 4, said ionic preconcentration cell further comprising:

a cell collector body maintaining a position of said upper and lower high surface area electrodes and said upper x-ray transmission window relative to one another, said cell collector body comprising a material selected from a material group consisting of: plastic, glass, and fiberglass.

17. (previously presented) The system of claim 4, said ionic preconcentration cell further comprising:

a cell collector body maintaining a position of said upper and lower high surface area electrodes and said upper x-ray transmission window relative to one another, said cell collector body comprising a non-conducting, machinable polymer substantially resistant to radiation degradation.

18. (previously presented) The system of claim 1:

said upper high surface area electrode further comprising an upper electrode thickness less than or equal to approximately $\ell = 1/(\mu * \rho)$, wherein:

ℓ designates an optical depth of said upper high surface area electrode when wetted with an element of interest for which a fluidic concentration is to be measured, in said fluid;

μ designates a mass absorption coefficient of said upper high surface area electrode when wetted with said element of interest in said fluid; and

ρ designates a material density of said upper high surface

area electrode when wetted with said element of interest in said fluid.

19. (previously presented) The system of claim 18:

said lower high surface area electrode further comprising a lower electrode thickness less than or equal to approximately $\ell = 1/(\mu*\rho)$, wherein:

ℓ designates an optical depth of said lower high surface area electrode when wetted with an element of interest for which a fluidic concentration is to be measured, in said fluid;

μ designates a mass absorption coefficient of said lower high surface area electrode when wetted with said element of interest in said fluid; and

ρ designates a material density of said lower high surface area electrode when wetted with said element of interest in said fluid.

20. (original) The system of claim 1, said upper high surface area electrode and said lower high surface area electrode further comprising an ordinary surface area approximately equal to an interrogation spot area of x-rays to which said preconcentration cell is to be exposed.

21. (previously presented) The system of claim 4, said upper x-ray transmission window comprising a surface area approximately equal to an interrogation spot area of x-rays to which said preconcentration cell is to be exposed.

22. (previously presented) The system of claim 2, said central flow interelectrode gap comprising said predetermined

interelectrode gap width, designated *d*, within an interelectrode gap range specified by:

$$d=\frac{\sigma\Phi}{q\varepsilon}\frac{w_i}{w_f}\frac{A}{n_f CF}\times 100\% \approx 2\times 10^{-9}\frac{\Phi w_i A}{q\varepsilon w_f n_f F}\times 100\% \propto \frac{\Phi A}{\varepsilon F},$$ wherein:

ε designates a predetermined percentage of at least one element of interest to be extracted from said fluid, σ designates a composite conductivity of said fluid, Φ designates a potential applied by said voltage application means across said electrodes, $q = 1.60\times10^{-19}$ Coulomb designates the unit charge, A designates an ordinary surface area covered by said electrodes, n_f designates a number density of said fluid, w_i and w_f designate atomic / molecular weights, respectively, of said at least one element of interest and of said fluid, C designates a concentration of said at least one element of interest in said fluid, and F designates a flow rate of said fluid through said ionic preconcentration cell;

said high surface area electrodes further comprise said ordinary surface area A approximately equal to an interrogation spot area of x-rays to which said preconcentration cell is to be exposed;

said ε is chosen to be below approximately 5% for said at least one element of interest;

said Φ is chosen to be below an electrochemical potential of said at least one element of interest and below an electrolysis potential of said fluid;

said F is chosen to exert no more than approximately .1 atm

of pressure upon an upper x-ray transmission window of said ionic preconcentration cell in intimate contact with an upper surface of said upper high surface area electrode;

said n_f and said w_f are chosen with reference to said at least one element of interest; and

said w_i is chosen with reference to said fluid.

23. (previously presented) The system of claim 22, said central flow interelectrode gap comprising said predetermined interelectrode gap width, *d*, with:

a minimum gap width selected from a minimum gap width group consisting of 2 mm, 1 mm, .5 mm, and .25 mm; and

a maximum gap width selected from a maximum gap width group consisting of 2 mm, 5 mm, and 10 mm.

24. (previously presented) The system of claim 4, said upper x-ray transmission window comprising:

an atomic number below 10;

structural rigidity to support up to 1/10 atm. of pressure without bowing more than approximately 100 microns;

substantial impermeability relative to said fluid;

x-ray transparency greater than 90% for characteristic photon energies from an element of interest for which a fluidic concentration is to be measured;

x-ray scattering therefrom minimized to less than approximately 10% of radiation scattered from a column of said fluid equal to one optical depth in said fluid of a characteristic photonic energy from an element of interest for which a fluidic concentration is to be measured; and

freedom from any single contaminant in excess of 1 part per million, when measured by x-ray fluorescence.

25. (previously presented) The system of claim 5, said lower x-ray transmission window comprising:

an atomic number below 10;

structural rigidity to support up to 1/10 atm. of pressure without bowing more than approximately 100 microns;

substantial impermeability relative to said fluid;

x-ray transparency greater than 90% for characteristic photon energies from an element of interest for which a fluidic concentration is to be measured;

x-ray scattering therefrom minimized to less than approximately 10% of radiation scattered from a column of said fluid equal to one optical depth in said fluid of a characteristic photonic energy from an element of interest for which a fluidic concentration is to be measured; and

freedom from any single contaminant in excess of 1 part per million, when measured by x-ray fluorescence.

26. (previously presented) The system of claim 4, said upper x-ray transmission window comprising a polyimid film comprising structural rigidity to support up to 1/10 atm. of pressure without bowing more than approximately 100 microns.

27. (previously presented) The system of claim 5, said lower x-ray transmission window comprising a polyimid film comprising structural rigidity to support up to 1/10 atm. of pressure without bowing more than approximately 100 microns.

28. (previously presented) The system of claim 1:

said upper high surface area electrode and said lower high surface area electrode each comprising a high surface area material in turn comprising:

a large plurality of pores characterized by a specific surface area of at least approximately 100 m^2/g;

an average pore diameter of said pores between approximately 30 nm and 10 nm per pore;

a distribution of the pore diameters grouped with a standard deviation of less than approximately 10nm around said average pore diameter;

an x-ray transparency greater than approximately 90% for characteristic photon energies from an element of interest for which a fluidic concentration is to be measured;

electrical conductivity of 10-40 mOhms-cm when fabricated into a ¼ mm thick electrode;

the ability to contain approximately at least 0.1% by weight of foreign material relative to said high surface area material prior to saturation;

high structural rigidity wherein a displacement under the flow of said fluid does not exceed approximately 0.25mm;

high wetting ability wherein an approximately ¼ mm thick sheet of said high surface area material becomes substantially wetted in less than approximately three seconds; and

freedom from metallic impurities in excess of approximately .5 parts per million, when measured by x-ray fluorescence analysis.

30. (previously presented) The system of claim 28, said large plurality of pores characterized by a specific surface area of at most approximately 1000 m^2/g.

31. (previously presented) The system of claim 29, said large plurality of pores characterized by a specific surface area of at most approximately 1000 m^2/g.

32. (previously presented) The system of claim 1, said upper high surface area electrode and said lower high surface area electrode each comprising a high surface area material in turn comprising:

an x-ray transparency greater than approximately 90% for characteristic photon energies from an element of interest for which a fluidic concentration is to be measured.

33. (original) The system of claim 1, said upper high surface area electrode and said lower high surface area electrode each comprising a carbon aerogel.

34. (previously presented) The system of claim 1, said upper high surface area electrode comprising a thickness less than approximately $\ell = 1/(\mu * \rho)$; wherein:

ℓ designates an optical depth of said upper high surface area electrode when wetted with said fluid;

μ designates a mass absorption coefficient of said high surface area electrode when wetted with said fluid; and

ρ designates a density of said high surface area electrode

when wetted with said fluid.

35. (previously presented) The system of claim 34, said lower high surface area electrode comprising a thickness less than approximately $\ell = 1/(\mu * \rho)$; wherein:

ℓ designates an optical depth of said lower high surface area electrode when wetted with said fluid;

μ designates a mass absorption coefficient of said lower surface area electrode when wetted with said fluid; and

ρ designates a density of said lower surface area electrode when wetted with said fluid.

36. (new) The system of claim 1, said calibration data further comprising:

background data comprising data related to a rate at which photons are detected to be emitted from at least one background data energy channel of said preconcentration cell, when said preconcentration cell is filled with a highly purified form of a fluid of interest and exposed to x-rays.

37. (previously presented) The system of claim 1, said calibration data further comprising:

sensitivity data related to a rate at which photons are detected to be emitted from at least one sensitivity data energy channel of said preconcentration cell, when said preconcentration cell is filled with a first calibration solution, containing at least one element of interest in a fluid of interest in known concentration above a minimum detection level of x-ray detection equipment to be used for said detecting and measuring, and when said preconcentration cell is exposed to x-rays.

38. (previously presented) The system of claim 2, said calibration data further comprising:

ion extraction rate data related to a rate at which photons are detected to be emitted from at least one ion extraction rate data energy channel of said preconcentration cell, when a calibration solution, containing said at least one element of interest in a fluid of interest in known concentration below a minimum detection level of x-ray detection equipment to be used for said detecting and measuring, is flowed through the central flow interelectrode gap of said preconcentration cell, at a substantially constant flow rate, while the voltage application means applies the voltage differential across the electrodes of said preconcentration cell, below an electrochemical potential of said at least one element of interest and below an electrolysis potential of said calibration solution, and when said preconcentration cell is exposed to x-rays.

39. (previously presented) The system of claim 2, said calibration data further comprising:

background data related to a rate at which photons are detected to be emitted from at least one background data energy channel of said preconcentration cell, when said preconcentration cell is filled with a highly purified form of a fluid of interest and exposed to x-rays;

sensitivity data related to a rate at which photons are detected to be emitted from at least one sensitivity data energy channel of said preconcentration cell, when said preconcentration cell is filled with a first calibration solution, containing at

least one element of interest in said fluid of interest in known concentration above a minimum detection level of x-ray detection equipment to be used for said detecting and measuring, and when said preconcentration cell is exposed to x-rays; and

ion extraction rate data related to a rate at which photons are detected to be emitted from at least one ion extraction rate data energy channel of said preconcentration cell, when a second calibration solution, containing said at least one element of interest in said fluid of interest in known concentration below said minimum detection level of x-ray detection equipment to be used for said detecting and measuring, is flowed through the central flow interelectrode gap of said preconcentration cell, at a substantially constant flow rate, while the voltage application means applies the voltage differential across the electrodes of said preconcentration cell, below an electrochemical potential of said at least one element of interest and below an electrolysis potential of said second calibration solution, and when said preconcentration cell is exposed to x-rays.

40. (previously presented) The system of claim 2, further comprising:

test data accumulation means for obtaining said test data comprising data related to a rate at which photons are detected to be emitted from at least one energy channel of said preconcentration cell when said fluid, suspected to contain at least one element of interest, is flowed through said central flow interelectrode gap at a substantially constant flow rate, while said voltage application means applies said voltage

differential across said electrodes below an electrochemical potential of said at least one element of interest and below an electrolysis potential of said fluid, and when said preconcentration cell is exposed to x-rays.

41. (original) The system of claim 40, further comprising:

analysis means for analyzing said test data and deducing therefrom a concentration in said fluid, if any, of the suspected at least one element of interest.

42. (previously presented) The system of claim 39, further comprising:

test data accumulation means for obtaining said test data comprising data related to a rate at which photons are detected to be emitted from at least one energy channel of said preconcentration cell when said fluid, suspected to contain at least one element of interest, is flowed through said central flow interelectrode gap at a substantially constant flow rate, while said voltage application means applies said voltage differential across said electrodes below an electrochemical potential of said at least one element of interest and below an electrolysis potential of said fluid, and when said preconcentration cell is exposed to x-rays.

43. (original) The system of claim 42, further comprising:

analysis means for analyzing said test data in relation to said background data, said sensitivity data, and said ion extraction rate data, and deducing therefrom a concentration in said fluid, if any, of the suspected at least one element of interest.

44. (previously presented) The system of claim 4, further comprising:

voltage application means for applying a voltage differential between said upper high surface area electrode and said lower high surface area electrode while said fluid is flowing through said central flow interelectrode gap; and

x-ray source means positioned and aligned relative to said upper x-ray transmission window for exposing said preconcentration cell to x-rays substantially transmitted through said upper x-ray transmission window, while flowing said fluid and while applying said voltage differential.

45. (previously presented) The system of claim 2, said voltage application means further comprising:

a transportable voltage supply for applying an electrostatic charge across said electrodes and thereby maintaining ions from said at least one element entrained in said electrodes during transport of said ionic preconcentration cell: after ceasing flow of said fluid, while transporting said ionic preconcentration cell to an x-ray source means for emitting x-rays toward said preconcentration cell, and while exposing said preconcentration cell to x-rays.

46. (original) The system of claim 1, further comprising:

flow control means for controlling a flow rate of said fluid through said ionic preconcentration cell so as to maintain ε, which designates a predetermined percentage of at least one element of interest to be extracted from said fluid, below approximately 5% for said at least one element of interest.

47. (previously presented) The system of claim 46, wherein said ε is maintained below an extraction percentage selected from an extraction percentage group consisting of approximately 4%, 3%, 2%, and 1%.

48. (previously presented) The system of claim 2, further comprising flow control means for:

controlling a flow rate F of said fluid through said ionic preconcentration cell and maintaining said F at a substantially constant level so as to maintain ε, which designates a predetermined percentage of at least one element of interest to be extracted from said fluid and is specified by:

$$\varepsilon = \frac{\Gamma_{ie}}{\Gamma_{is}} = \frac{\sigma \Phi}{q d} \frac{w_i}{w_f} \frac{A}{n_f C F} \times 100\% ,$$

below approximately 5% for said at least one element of interest; wherein:

Γ_{ie} and Γ_{is} designate rates at which ions of said at least one element of interest are respectively extracted from said fluid by said cell and supplied to said cell by said fluid, σ designates a composite conductivity of said fluid, Φ designates a potential applied by said voltage application means across said electrodes, d designates said predetermined interelectrode gap width of said central flow interelectrode gap, $q = 1.60 \times 10^{-19}$ Coulomb designates the unit charge, A designates an ordinary surface area covered by said electrodes, n_f designates a number density of said fluid, w_i and w_f designate atomic / molecular weights, respectively, of said at least one element of interest and of said fluid, and C designates a concentration of said at

least one element of interest in said fluid; and

for having said concentration *C* in a range where conductivity varies substantially linearly with concentration, with *C* in units of parts per billion, wherein σ is approximated by:

$$\sigma \approx 2 \times 10^{-9}\, C / \mathrm{Ohm-cm}\ .$$

49. (previously presented) The system of claim 48, wherein said ε is maintained below an extraction percentage selected from an extraction percentage group consisting of approximately 4%, 3%, 2%, and 1%.

50. (original) The system of claim 2, said voltage application means applying said voltage differential across said electrodes below an electrochemical potential of at least one element of interest and below an electrolysis potential of said fluid.

51. (previously presented) The system of claim 1, further comprising:

leakage current monitoring means for monitoring a total non-saturated concentration of dissolved ions in said upper and lower high surface area electrodes, by monitoring a leakage current from said cell.

52. (previously presented) The system of claim 51, further comprising:

ultra-low trace measuring means for measuring at least one element of interest comprising ultra-low trace, high valence ions in said fluid, based on said detecting the non-saturated saturation state.

53. (previously presented) The system of claim 1, further comprising:

leakage current monitoring means for monitoring a total non-saturated concentration of dissolved ions in said upper and lower high surface area electrodes; and

flow rate adjustment means for adjusting the flow of said fluid through said ionic preconcentration cell to control a percentage of said ions extracted from said fluid, based on said monitoring of said leakage current by said leakage current monitoring means.

54. (previously presented) The system of claim 1, further comprising:

time control means for controlling how long said fluid flows through said ionic preconcentration cell based on setting an impurity concentration *C*, in a range where conductivity varies substantially linearly with concentration, to a predetermined desired concentration detection level and flowing said fluid for a time *t* given by:

$t \propto \frac{S\ell}{\sigma} \propto \frac{S\ell}{C}$; wherein:

S designates a sensitivity of x-ray detection equipment to be used for said detecting and measuring;

ℓ designates a thickness of said upper high surface area electrode; and

σ designates a composite conductivity of said fluid.

55. (previously presented) The system of claim 1, further comprising triggering means for triggering an action in response

to said system detecting that a concentration of at least one element of interest in said fluid has passed a predetermined, non-saturated threshold concentration.

56. (previously presented) The system of claim 55, further comprising injection action means for injecting at least one element into said fluid, thereby maintaining said concentration within a predetermined concentration range, as said action in response to said triggering means.

57. (previously presented) The system of claim 55, further comprising dilution action means for diluting at least one diluting fluid into said fluid, thereby maintaining said concentration within a predetermined concentration range, as said action in response to said triggering means.

58. (previously presented) The system of claim 1, further comprising:

ionic release means for cleaning said preconcentration cell after use by releasing ions accumulated within said high specific surface area of said electrodes into said fluid, after the accumulated ions have been exposed to x-rays and fluorescence from said preconcentration cell has been detected.

59. (previously presented) The system of claim 4, further comprising:

x-ray source means positioned and aligned relative to said upper x-ray transmission window for emitting x-rays toward said preconcentration cell substantially transmitted through said upper x-ray transmission window; and

x-ray fluorescence detector means positioned and aligned

relative to said upper x-ray transmission window for detecting fluoresced energy emitted by said preconcentration cell due to said emitting x-rays toward said preconcentration cell, through said upper x-ray transmission window.

60. (previously presented) The system of claim 59, further comprising:

x-ray fluorescence analysis means for analyzing the detected x-ray fluoresced energy and deducing therefrom a concentration in said fluid of at least one element of interest in said fluid.

61. (previously presented) The system of claim 1, further comprising:

a telecommunications link for downloading and analyzing said test data from said ionic preconcentration cell.

62. (previously presented) A method for identifying and measuring concentrations of elements in fluids, comprising the steps of:

flowing a fluid through a central flow interelectrode gap of an ionic preconcentration cell separating an upper high specific surface area electrode from a lower high specific surface area electrode of said ionic preconcentration cell by a predetermined interelectrode gap width;

applying a known voltage differential between said upper high surface area electrode and said lower high surface area electrode while said fluid is flowing through said central flow interelectrode gap;

exposing said cell to x-rays; and ~~under test conditions and obtaining test data characterizing a response thereto of said~~

~~cell; and~~

~~deducing an identity, or measurement of concentration, of at least one element in said fluid, using said test data in combination with calibration data,~~

deducing an an identity, or measurement of concentration, of an unknown concentration of at least one element of interest in said a fluid of interest, based on comparing calibration data with test data related to a rate at which photons are detected to be emitted from said preconcentration cell based on said fluid of interest with said unknown concentration flowing through said central flow interelectrode gap at a known flow rate for a known period of time together with said applying said known voltage differential and said exposing said cell to x-rays, wherein said calibration data is obtained by:

flowing a fluid of interest containing a known concentration of at least one element of interest through said central flow interelectrode gap at a known rate for a known period of time~~filling said preconcentration cell, with a highly purified form of a fluid of interest~~;

applying a known voltage differential across said electrodes

exposing the ~~filled~~ preconcentration cell to x-rays; and

acquiring data related to a rate at which photons are detected to be emitted from said preconcentration cell~~background data related to a rate at which photons are detected to be emitted from at least one background data energy channel of said preconcentration cell; and~~

~~associating said background data with said preconcentration~~

~~cell~~.

63. (previously presented) The method of claim 62, said step of applying said voltage differential further comprising the step of:

applying an electrostatic charge across said electrodes and thereby maintaining ions from said at least one element entrained in said electrodes during transport of said ionic preconcentration cell, using a transportable voltage supply.

64. (previously presented) The method of claim 62, further comprising the step of:

intimately contacting an upper surface of said upper high surface area electrode with an upper x-ray transmission window of said ionic preconcentration cell.

65. (previously presented) The method of claim 64, further comprising the step of:

intimately contacting a lower surface of said lower high surface area electrode with a lower x-ray transmission window of said ionic preconcentration cell.

66. (original) The method of claim 62, further comprising the steps of:

entering a fluid into said ionic preconcentration cell using inlet flow means therefor; and

enabling said fluid to flow through said central flow interelectrode gap.

67. (previously presented) The method of claim 66, said step of entering said fluid further comprising entering said fluid through said inlet flow means comprising at least one mutually-

planar inlet flow slot substantially coplanar with said central flow interelectrode gap.

68. (previously presented) The method of claim 66, said step of entering said fluid further comprising entering said fluid through said inlet flow means comprising a plurality of substantially coplanar inlet flow tubes substantially coplanar with said central flow interelectrode gap and substantially parallel with one another.

69. (previously presented) The method of claim 66, further comprising the step of enhancing a turbulence of the flow of said fluid while entering said fluid, thereby inducing mixing of said flow for enabling uniform extraction of said at least one element from the flow stream.

70. (previously presented) The method of claim 66, further comprising the step of physically cleaning debris from said inlet flow means using access means for accessing said inlet flow means.

71. (original) The method of claim 62, further comprising the step of:

exiting said fluid out from said ionic preconcentration cell after said fluid has flowed through said central flow interelectrode gap using outlet flow means therefor.

72. (previously presented) The method of claim 71, said step of exiting said fluid further comprising exiting said fluid through said outlet flow means comprising at least one outlet flow slot substantially coplanar with said central flow interelectrode gap.

73. (previously presented) The method of claim 71, said step of exiting said fluid further comprising exiting said fluid through said outlet flow means comprising a plurality of outlet flow tubes substantially coplanar with said central flow interelectrode gap and substantially parallel with one another.

74. (previously presented) The method of claim 71, further comprising the step of physically cleaning debris from said outlet flow means using access means for accessing said outlet flow means.

75. (previously presented) The method of claim 64, further comprising the step of:

maintaining a position of said upper and lower high surface area electrodes and said upper x-ray transmission window relative to one another, using a body of said ionic preconcentration cell comprising a material comprising:

substantially no conductivity;

resistance to ionic leaching; and

resistance to radiation degradation from x-rays to which said preconcentration cell is to be exposed.

76. (previously presented) The method of claim 64, further comprising the step of:

maintaining a position of said upper and lower high surface area electrodes and said upper x-ray transmission window relative to one another, using a body of said ionic preconcentration cell comprising a material selected from a material group consisting of: plastic, glass, and fiberglass.

77. (previously presented) The method of claim 64, further comprising the step of:

maintaining a position of said upper and lower high surface area electrodes and said upper x-ray transmission window relative to one another, using a body of said ionic preconcentration cell comprising a material comprising a non-conducting, machinable polymer substantially resistant to radiation degradation.

78. (previously presented) The method of claim 62, further comprising the step of:

providing said upper high surface area electrode with an upper electrode thickness thereof less than or equal to approximately $\ell = 1/(\mu*\rho)$, wherein:

ℓ designates an optical depth of said upper high surface area electrode when wetted with an element of interest for which a fluidic concentration is to be measured, in said fluid;

μ designates a mass absorption coefficient of said upper high surface area electrode, when wetted with said element of interest in said fluid; and

ρ designates a material density of said upper high surface area electrode, when wetted with said element of interest in said fluid.

79. (previously presented) The method of claim 78, further comprising the step of:

providing said lower high surface area electrode with a lower electrode thickness thereof less than or equal to approximately $\ell = 1/(\mu*\rho)$, wherein:

ℓ designates an optical depth of said lower high surface area electrode when wetted with an element of interest for which a fluidic concentration is to be measured, in said fluid;

μ designates a mass absorption coefficient of said lower high surface area electrode, when wetted with said element of interest in said fluid; and

ρ designates a material density of said lower high surface area electrode, when wetted with said element of interest in said fluid.

80. (original) The method of claim 62, further comprising the step of:

providing ordinary surface areas of said upper high surface area electrode and said lower high surface area electrode approximately equal to an interrogation spot area of x-rays to which said preconcentration cell is to be exposed.

81. (previously presented) The method of claim 64, further comprising the step of:

providing a surface area of said upper x-ray transmission window approximately equal to an interrogation spot area of x-rays to which said preconcentration cell is to be exposed.

82. (previously presented) The method of claim 62, further comprising the step of:

providing said central flow interelectrode gap comprising said predetermined interelectrode gap width, designated d, within an interelectrode gap range specified by:

$$d = \frac{\sigma\Phi}{q\varepsilon}\frac{w_i}{w_f}\frac{A}{n_f C F}\times 100\% \approx 2\times 10^{-9}\,\frac{\Phi w_i A}{q\varepsilon w_f n_f F}\times 100\% \propto \frac{\Phi A}{\varepsilon F};$$ wherein:

ε designates a predetermined percentage of at least one element of interest to be extracted from said fluid, σ designates a composite conductivity of said fluid, Φ designates said voltage differential applied across said electrodes, $q = 1.60 \times 10^{-19}$ Coulomb designates the unit charge, A designates an ordinary surface area covered by said electrodes, n_f designates a number density of said fluid, w_i and w_f designate atomic / molecular weights, respectively, of said at least one element of interest and of said fluid, C designates a concentration of said at least one element of interest in said fluid, and F designates a flow rate of said fluid through said ionic preconcentration cell;

said high surface area electrodes further comprise said ordinary surface area A approximately equal to an interrogation spot area of x-rays to which said preconcentration cell is to be exposed;

said ε is chosen to be below approximately 5% for said at least one element of interest;

said Φ is chosen to be below an electrochemical potential of said at least one element of interest and below an electrolysis potential of said fluid;

said F is chosen to exert no more than approximately .1 atm of pressure upon an upper x-ray transmission window of said ionic preconcentration cell in intimate contact with an upper surface of said upper high surface area electrode;

said n_f and said w_f are chosen with reference to said at least one element of interest; and

said w_i is chosen with reference to said fluid.

83. (previously presented) The method of claim 82, further comprising the step of:

providing said central flow interelectrode gap comprising said predetermined interelectrode gap width, *d*, with:

a minimum gap width selected from a minimum gap width group consisting of 2 mm, 1 mm, .5 mm, and .25 mm; and

a maximum gap width selected from a maximum gap width group consisting of 2 mm, 5 mm, and 10 mm.

84. (previously presented) The method of claim 64, further comprising the step of providing said upper x-ray transmission window comprising:

an atomic number below 10;

structural rigidity to support up to 1/10 atm. of pressure without bowing more than approximately 100 microns;

substantial impermeability relative to said fluid;

x-ray transparency greater than 90% for characteristic photon energies from an element of interest for which a fluidic concentration is to be measured;

x-ray scattering therefrom minimized to less than approximately 10% of radiation scattered from a column of said fluid equal to one optical depth in said fluid of a characteristic photonic energy from an element of interest for which a fluidic concentration is to be measured; and

freedom from any single contaminant in excess of 1 part per million, when measured by x-ray fluorescence.

85. (previously presented) The method of claim 65, further comprising the step of providing said lower x-ray transmission window comprising:

an atomic number below 10;

structural rigidity to support up to 1/10 atm. of pressure without bowing more than approximately 100 microns;

substantial impermeability relative to said fluid;

x-ray transparency greater than 90% for characteristic photon energies from an element of interest for which a fluidic concentration is to be measured;

x-ray scattering therefrom minimized to less than approximately 10% of radiation scattered from a column of said fluid equal to one optical depth in said fluid of a characteristic photonic energy from an element of interest for which a fluidic concentration is to be measured; and

freedom from any single contaminant in excess of 1 part per million, when measured by x-ray fluorescence.

86. (previously presented) The method of claim 64, further comprising the step of:

providing said upper x-ray transmission window comprising a polyimid film comprising structural rigidity to support up to 1/10 atm. of pressure without bowing more than approximately 100 microns.

87. (previously presented) The method of claim 65, further comprising the step of:

providing said lower x-ray transmission window comprising a polyimid film comprising structural rigidity to support up to

1/10 atm. of pressure without bowing more than approximately 100 microns.

88. (previously presented) The method of claim 62 further comprising the step of:

providing said upper high surface area electrode and said lower high surface area electrode each comprising a high surface area material in turn comprising:

a large plurality of pores characterized by a specific surface area of at least approximately 100 m^2/g;

an average pore diameter of said pores between approximately 30 nm and 10 nm per pore;

a distribution of the pore diameters grouped with a standard deviation of less than approximately 10nm around said average pore diameter;

an x-ray transparency greater than approximately 90% for characteristic photon energies from an element of interest for which a fluidic concentration is to be measured;

electrical conductivity of 10-40 mOhms-cm when fabricated into a ¼ mm thick electrode;

the ability to contain approximately at least 0.1% by weight of foreign material relative to said high surface area material prior to saturation;

high structural rigidity wherein a displacement under the flow of said fluid does not exceed approximately 0.25mm;

high wetting ability wherein an approximately ¼ mm thick sheet of said high surface area material becomes substantially wetted in less than approximately three seconds; and

freedom from metallic impurities in excess of approximately .5 parts per million, when measured by x-ray fluorescence analysis.

89. (previously presented) The method of claim 88, said large plurality of pores characterized by a specific surface area of at least approximately 400 m^2/g.

90. (previously presented) The method of claim 88, said large plurality of pores characterized by a specific surface area of at most approximately 1000 m^2/g.

91. (previously presented) The method of claim 89, said large plurality of pores characterized by a specific surface area of at most approximately 1000 m^2/g.

92. (previously presented) The method of claim 62, further comprising the step of:

providing said upper high surface area electrode and said lower high surface area electrode each comprising a high surface area material in turn comprising:

an x-ray transparency greater than approximately 90% for characteristic photon energies from an element of interest for which a fluidic concentration is to be measured.

93. (original) The method of claim 62, further comprising the step of:

providing said upper high surface area electrode and said lower high surface area electrode each comprising a carbon aerogel.

94. (previously presented) The method of claim 62, further comprising the step of:

providing said upper high surface area electrode with a thickness less than approximately $\ell = 1/(\mu*\rho)$; wherein:

ℓ designates an optical depth of said upper high surface area electrode when wetted with said fluid;

μ designates a mass absorption coefficient of said high surface area electrode when wetted with said fluid; and

ρ designates a density of said high surface area electrode when wetted with said fluid.

95. (previously presented) The method of claim 94, further comprising the step of:

providing said lower high surface area electrode with a thickness less than approximately $\ell = 1/(\mu*\rho)$; wherein:

ℓ designates an optical depth of said lower high surface area electrode when wetted with said fluid;

μ designates a mass absorption coefficient of said lower surface area electrode when wetted with said fluid; and

ρ designates a density of said lower surface area electrode when wetted with said fluid.

96. (new) The method of claim 62, further comprising the step of obtaining said calibration data by:

filling said preconcentration cell with a highly purified form of a fluid of interest;

exposing the filled preconcentration cell to x-rays; and

acquiring background data related to a rate at which photons are detected to be emitted from at least one background data energy channel of said preconcentration cell; and

associating said background data with said preconcentration cell.

97. (previously presented) The method of claim 62, further comprising the step of obtaining said calibration data by:

filling said preconcentration cell, with a first calibration solution containing at least one element of interest in a fluid of interest in known concentration above a minimum detection level of x-ray detection equipment to be used for said detecting and measuring;

exposing the filled preconcentration cell to x-rays;

acquiring sensitivity data related to a rate at which photons are detected to be emitted from at least one sensitivity data energy channel of said preconcentration cell; and

associating said sensitivity data with said preconcentration cell.

98. (previously presented) The method of claim 62, further comprising the step of obtaining said calibration data by:

applying said voltage differential across the electrodes of said preconcentration cell, below an electrochemical potential of said at least one element of interest and below an electrolysis potential of a calibration solution;

flowing said calibration solution containing said at least one element of interest in a fluid of interest in known concentration below a minimum detection level of x-ray detection equipment to be used for said detecting and measuring through the central flow interelectrode gap of said preconcentration cell at a substantially constant flow rate;

exposing said preconcentration cell with said calibration solution therein to x-rays;

acquiring ion extraction rate data related to a rate at which photons are detected to be emitted from at least one ion extraction rate data energy channel of said preconcentration cell; and

associating said ion extraction rate data with said preconcentration cell.

99. (previously presented) The method of claim 62, further comprising the step of obtaining said calibration data by:

filling said preconcentration cell, with a highly purified form of a fluid of interest;

exposing the filled preconcentration cell to x-rays;

acquiring background data related to a rate at which photons are detected to be emitted from at least one background data energy channel of said preconcentration cell;

filling said preconcentration cell, with a first calibration solution containing at least one element of interest in said fluid of interest in known concentration above a minimum detection level of x-ray detection equipment to be used for said detecting and measuring;

exposing the filled preconcentration cell to x-rays;

acquiring sensitivity data related to a rate at which photons are detected to be emitted from at least one sensitivity data energy channel of said preconcentration cell;

applying said voltage differential across the electrodes of said preconcentration cell, below an electrochemical potential of

said at least one element of interest and below an electrolysis potential of a second calibration solution;

flowing said second calibration solution containing said at least one element of interest in said fluid of interest in known concentration below a minimum detection level of x-ray detection equipment to be used for said detecting and measuring through the central flow interelectrode gap of said preconcentration cell, at a substantially constant flow rate;

exposing said preconcentration cell with said second calibration solution therein to x-rays;

acquiring ion extraction rate data related to a rate at which photons are detected to be emitted from at least one ion extraction rate data energy channel of said preconcentration cell; and

associating said background data, said sensitivity data, and said ion extraction rate data with said preconcentration cell.

100. (previously presented) The method of claim 62, further comprising the steps of:

applying said voltage differential across said electrodes below an electrochemical potential of said at least one element of interest and below an electrolysis potential of said fluid, suspected to contain at least one element of interest;

flowing said fluid through said central flow interelectrode gap at a substantially constant flow rate;

exposing said preconcentration cell with said fluid therein to x-rays; and

acquiring said test data related to a rate at which photons

are detected to be emitted from at least one test data energy channel of said preconcentration cell.

101. (original) The method of claim 100, further comprising the step of:

analyzing said test data and deducing therefrom a concentration in said fluid, if any, of the suspected at least one element of interest.

102. (previously presented) The method of claim 99, further comprising the steps of:

applying said voltage differential across said electrodes below an electrochemical potential of said at least one element of interest and below an electrolysis potential of said fluid, suspected to contain at least one element of interest;

flowing said fluid through said central flow interelectrode gap at a substantially constant flow rate;

exposing said preconcentration cell with said fluid therein to x-rays; and

acquiring said test data related to a rate at which photons are detected to be emitted from at least one test data energy channel of said preconcentration cell.

103. (original) The method of claim 102, further comprising the step of:

analyzing said test data in relation to said background data, said sensitivity data, and said ion extraction rate data, and deducing therefrom a concentration in said fluid, if any, of the suspected at least one element of interest.

104. (previously presented) The method of claim 62, further comprising the step of:

exposing said preconcentration cell to x-rays substantially transmitted through said upper x-ray transmission window, while flowing said fluid and while applying said voltage differential.

105. (previously presented) The method of claim 62, said step of applying said voltage differential further comprising the steps of:

ceasing flow of said fluid while applying an electrostatic charge across said electrodes and thereby maintaining ions from said at least one element entrained in said electrodes;

transporting said ionic preconcentration cell to an x-ray source means for emitting x-rays toward said preconcentration cell while applying said electrostatic charge; and

exposing said preconcentration cell to x-rays from said x-ray source means while applying said electrostatic charge.

106. (previously presented) The method of claim 62, further comprising the step of:

controlling a flow rate of said fluid through said ionic preconcentration cell so as to maintain ε, which designates a predetermined percentage of at least one element of interest to be extracted from said fluid, below approximately 5% for said at least one element of interest.

107. (previously presented) The method of claim 106, further comprising the step of:

maintaining said ε below an extraction percentage selected from an extraction percentage group consisting of approximately

4%, 3%, 2%, and 1%.

108. (previously presented) The method of claim 62, further comprising the step of:

controlling a flow rate F of said fluid through said ionic preconcentration cell and maintaining said F at a substantially constant level so as to maintain ε, which designates a predetermined percentage of at least one element of interest to be extracted from said fluid and is specified by:

$$\varepsilon = \frac{\Gamma_{ie}}{\Gamma_{is}} = \frac{\sigma\Phi}{qd}\frac{w_i}{w_f}\frac{A}{n_f CF}\times 100\%,$$

below approximately 5% for said at least one element of interest; wherein:

Γ_{ie} and Γ_{is} designate rates at which ions of said at least one element of interest are respectively extracted from said fluid by said cell and supplied to said cell by said fluid, σ designates a composite conductivity of said fluid, Φ designates said voltage differential applied across said electrodes, d designates said predetermined interelectrode gap width of said central flow interelectrode gap, $q = 1.60\text{x}10^{-19}$ Coulomb designates the unit charge, A designates an ordinary surface area covered by said electrodes, n_f designates a number density of said fluid, w_i and w_f designate atomic / molecular weights, respectively, of said at least one element of interest and of said fluid, and C designates a concentration of said at least one element of interest in said fluid; and

having said concentration C in a range where conductivity varies substantially linearly with concentration, with C in units

of parts per billion, wherein σ is approximated by:

$$\sigma \approx 2\times10^{-9}\, C/\mathrm{Ohm-cm}\ .$$

109. (previously presented) The method of claim 108, further comprising the step of:

maintaining said ε below an extraction percentage selected from an extraction percentage group consisting of approximately 4%, 3%, 2%, and 1%.

110. (original) The method of claim 62, further comprising the step of:

applying said voltage differential across said electrodes below an electrochemical potential of at least one element of interest and below an electrolysis potential of said fluid.

111. (previously presented) The method of claim 62, further comprising the step of:

monitoring a total non-saturated concentration of dissolved ions in said upper and lower high surface area electrodes, by monitoring a leakage current from said cell.

112. (previously presented) The method of claim 111, further comprising the step of:

measuring at least one element of interest comprising ultra-low trace, high valence ions in said fluid, based on said detecting the non-saturated saturation state.

113. (element of interest) The method of claim 62, further comprising the steps of:

monitoring a total non-saturated concentration of dissolved ions in said upper and lower high surface area electrodes by monitoring a leakage current in said cell; and

adjusting the flow of said fluid through said ionic preconcentration cell to control a percentage of said ions extracted from said fluid, based on said monitoring of said leakage current.

114. (previously presented) The method of claim 62, further comprising the steps of:

setting an impurity concentration C, in a range where conductivity varies substantially linearly with concentration, to a predetermined desired concentration detection level; and

controlling how long said fluid flows through said ionic preconcentration cell by flowing said fluid for a time t given by:

$t \propto \frac{S\ell}{\sigma} \propto \frac{S\ell}{C}$, wherein:

S designates a sensitivity of x-ray detection equipment to be used for said detecting and measuring;

ℓ designates a thickness of said upper high surface area electrode; and

σ designates a composite conductivity of said fluid.

115. (previously presented) The method of claim 62, further comprising the step of:

triggering an action in response to detecting that a concentration of at least one element of interest in said fluid has passed a predetermined, non-saturated threshold concentration.

116. (previously presented) The method of claim 115, said step of triggering further comprising the step of:

maintaining said concentration within a predetermined concentration range by injecting at least one element into said fluid as said action in response to said detecting.

117. (previously presented) The method of claim 115, said step of triggering further comprising the step of:

maintaining said concentration within a predetermined concentration range by diluting at least one diluting fluid into said fluid as said action in response to said detecting.

118. (previously presented) The method of claim 62, further comprising the step of:

cleaning said preconcentration cell after use by releasing ions accumulated within said high specific surface area of said electrodes into said fluid, after the accumulated ions have been exposed to x-rays and fluorescence from said preconcentration cell has been detected.

119. (previously presented) The method of claim 64, further comprising the steps of:

emitting x-rays toward said preconcentration cell substantially transmitted through said upper x-ray transmission window; and

detecting fluoresced energy emitted by said preconcentration cell due to said emitting x-rays toward said preconcentration cell, through said upper x-ray transmission window.

120. (previously presented) The method of claim 119, further comprising the step of:

analyzing the detected x-ray fluoresced energy and deducing therefrom a concentration in said fluid of at least one element

of interest in said fluid.

121. (previously presented) The method of claim 62, further comprising the step of:

downloading and analyzing said test data from said ionic preconcentration cell using a telecommunications link.

122. (previously presented) The system of claim 3, wherein:

said transportable voltage supply is embedded into a body of said ionic preconcentration cell.

123. (previously presented) The method of claim 63, further comprising the step of:

providing said transportable voltage supply embedded into a body of said ionic preconcentration cell.

124-138. (cancelled)

139. (previously presented) An ionic preconcentration cell apparatus for identifying and measuring concentrations of elements in fluids, comprising:

an upper high surface area electrode comprising a high specific surface area thereof;

a lower high surface area electrode comprising a high specific surface area thereof, substantially parallel to said upper high surface area electrode;

a central flow interelectrode gap separating said upper and lower high surface area electrodes by a predetermined interelectrode gap width;

fluid flow means for flowing a fluid through said central flow interelectrode gap; and

an upper x-ray transmission window in intimate contact with

an upper surface of said upper high surface area electrode; said upper x-ray transmission window comprising:

an atomic number below 10;

structural rigidity to support up to 1/10 atm. of pressure without bowing more than approximately 100 microns;

substantial impermeability relative to said fluid;

x-ray transparency greater than 90% for characteristic photon energies from an element of interest for which a fluidic concentration is to be measured;

x-ray scattering therefrom minimized to less than approximately 10% of radiation scattered from a column of said fluid equal to one optical depth in said fluid of a characteristic photonic energy from an element of interest for which a fluidic concentration is to be measured; and

freedom from any single contaminant in excess of 1 part per million, when measured by x-ray fluorescence.

140. (previously presented) An ionic preconcentration cell apparatus for identifying and measuring concentrations of elements in fluids, comprising:

an upper high surface area electrode comprising a high specific surface area thereof;

a lower high surface area electrode comprising a high specific surface area thereof, substantially parallel to said upper high surface area electrode;

a central flow interelectrode gap separating said upper and lower high surface area electrodes by a predetermined interelectrode gap width;

fluid flow means for flowing a fluid through said central flow interelectrode gap;

an upper x-ray transmission window in intimate contact with an upper surface of said upper high surface area electrode; and

a lower x-ray transmission window in intimate contact with a lower surface of said lower high surface area electrode; said lower x-ray transmission window comprising:

an atomic number below 10;

structural rigidity to support up to 1/10 atm. of pressure without bowing more than approximately 100 microns;

substantial impermeability relative to said fluid;

x-ray transparency greater than 90% for characteristic photon energies from an element of interest for which a fluidic concentration is to be measured;

x-ray scattering therefrom minimized to less than approximately 10% of radiation scattered from a column of said fluid equal to one optical depth in said fluid of a characteristic photonic energy from an element of interest for which a fluidic concentration is to be measured; and

freedom from any single contaminant in excess of 1 part per million, when measured by x-ray fluorescence.

141-156. (cancelled)

157. (previously presented) A method for identifying and measuring concentrations of elements in fluids, comprising the steps of:

flowing a fluid through a central flow interelectrode gap of an ionic preconcentration cell separating an upper high specific

surface area electrode from a lower high specific surface area electrode of said ionic preconcentration cell by a predetermined interelectrode gap width;

applying a voltage differential between said upper high surface area electrode and said lower high surface area electrode while said fluid is flowing through said central flow interelectrode gap;

passing x-rays through an upper x-ray transmission window intimately contacting an upper surface of said upper high surface area electrode;

deducing an identity, or measurement of concentration, of at least one element in said fluid based on a response of said preconcentration cell to said x-rays; and

providing said upper x-ray transmission window comprising:

an atomic number below 10;

structural rigidity to support up to 1/10 atm. of pressure without bowing more than approximately 100 microns;

substantial impermeability relative to said fluid;

x-ray transparency greater than 90% for characteristic photon energies from an element of interest for which a fluidic concentration is to be measured by said method;

x-ray scattering therefrom minimized to less than approximately 10% of radiation scattered from a column of said fluid equal to one optical depth in said fluid of a characteristic photonic energy from an element of interest for which a fluidic concentration is to be measured by said method; and

freedom from any single contaminant in excess of 1 part per million, when measured by x-ray fluorescence.

158. (previously presented) A method for identifying and measuring concentrations of elements in fluids, comprising the steps of:

flowing a fluid through a central flow interelectrode gap of an ionic preconcentration cell separating an upper high specific surface area electrode from a lower high specific surface area electrode of said ionic preconcentration cell by a predetermined interelectrode gap width;

applying a voltage differential between said upper high surface area electrode and said lower high surface area electrode while said fluid is flowing through said central flow interelectrode gap;

passing x-rays through an upper x-ray transmission window intimately contacting an upper surface of said upper high surface area electrode;

deducing an identity, or measurement of concentration, of at least one element in said fluid based on a response of said preconcentration cell to said x-rays;

passing said x-rays through a lower x-ray transmission window intimately contacting a lower surface of said lower high surface area electrode; and

providing said lower x-ray transmission window comprising:

an atomic number below 10;

structural rigidity to support up to 1/10 atm. of pressure without bowing more than approximately 100 microns;

substantial impermeability relative to said fluid;

x-ray transparency greater than 90% for characteristic photon energies from an element of interest for which a fluidic concentration is to be measured by said method;

x-ray scattering therefrom minimized to less than approximately 10% of radiation scattered from a column of said fluid equal to one optical depth in said fluid of a characteristic photonic energy from an element of interest for which a fluidic concentration is to be measured by said method; and

freedom from any single contaminant in excess of 1 part per million, when measured by x-ray fluorescence.

159-160. (cancelled)

161. (previously presented) A method of optimizing fabrication of an ionic preconcentration cell for identifying and measuring concentrations of elements in fluids; said ionic preconcentration cell comprising an upper high surface area electrode comprising a high specific surface area thereof; a lower high surface area electrode comprising a high specific surface area thereof; and a central flow interelectrode gap separating said upper and lower high surface area electrodes by a predetermined interelectrode gap width; said method comprising the step of:

optimizing said upper high surface area electrode with an upper electrode thickness less than or equal to approximately an optical depth ℓ of said upper high surface area electrode when wetted with a fluid to be flowed through said cell.

162. (previously presented) The optimization method of claim

161, wherein:

said $\ell = 1/(\mu * \rho)$; and wherein:

μ designates a mass absorption coefficient of said upper high surface area electrode when wetted with said fluid; and

ρ designates a material density of said upper high surface area electrode when wetted with said fluid.

163. (previously presented) The optimization method of claim 161, further comprising the step of:

optimizing said lower high surface area electrode with a lower electrode thickness less than or equal to approximately an optical depth ℓ of said lower high surface area electrode when wetted with said fluid.

164. (previously presented) The optimization method of claim 163, wherein:

said $\ell = 1/(\mu * \rho)$; and wherein:

μ designates a mass absorption coefficient of said lower high surface area electrode when wetted with said fluid; and

ρ designates a material density of said lower high surface area electrode when wetted with said fluid.

165. (previously presented) A method of optimizing fabrication of an ionic preconcentration cell for identifying and measuring concentrations of elements in fluids; said ionic preconcentration cell comprising an upper high surface area electrode comprising a high specific surface area thereof; a lower high surface area electrode comprising a high specific surface area thereof; and a central flow interelectrode gap separating said upper and lower

high surface area electrodes by a predetermined interelectrode gap width; said method comprising the step of:

optimizing said upper high surface area electrode with an upper electrode thickness less than or equal to approximately an optical depth ℓ of said upper high surface area electrode when wetted with an element of interest for which a fluidic concentration is to be measured by said cell, in a fluid to be flowed through said cell.

166. (previously presented) The optimization method of claim 165, wherein:

said $\ell = 1/(\mu * \rho)$; and wherein:

μ designates a mass absorption coefficient of said upper high surface area electrode when wetted with said element of interest in said fluid; and

ρ designates a material density of said upper high surface area electrode when wetted with said element of interest in said fluid.

167. (previously presented) The optimization method of claim 165, further comprising the step of:

optimizing said lower high surface area electrode with a lower electrode thickness less than or equal to approximately an optical depth ℓ of said lower high surface area electrode when wetted with said element of interest, in said fluid.

168. (previously presented) The optimization method of claim 167, wherein:

said $\ell = 1/(\mu * \rho)$; and wherein:

μ designates a mass absorption coefficient of said lower high surface area electrode when wetted with said element of interest in said fluid; and

ρ designates a material density of said lower high surface area electrode when wetted with said element of interest in said fluid.

169-176. (cancelled)

177. (previously presented) A method of optimizing fabrication of an ionic preconcentration cell for identifying and measuring concentrations of elements in fluids; said ionic preconcentration cell comprising an upper high surface area electrode comprising a high specific surface area thereof; a lower high surface area electrode comprising a high specific surface area thereof; and a central flow interelectrode gap separating said upper and lower high surface area electrodes by a predetermined interelectrode gap width; said method comprising the step of:

optimizing said central flow interelectrode gap comprising said predetermined interelectrode gap width, designated d, within an interelectrode gap range specified by:

$$d = \frac{\sigma\Phi}{q\varepsilon}\frac{w_i}{w_f}\frac{A}{n_f C F}\times 100\% \approx 2\times 10^{-9}\frac{\Phi w_i A}{q\varepsilon w_f n_f F}\times 100\% \propto \frac{\Phi A}{\varepsilon F};$$ wherein:

ε designates a predetermined percentage of at least one element of interest to be extracted from a fluid to be flowed through said cell, σ designates a composite conductivity of said fluid, Φ designates a voltage differential applied across said electrodes, q = 1.60x10^{-19} Coulomb designates the unit charge, A

designates an ordinary surface area covered by said electrodes, n_f designates a number density of said fluid, w_i and w_f designate atomic / molecular weights, respectively, of said at least one element of interest and of said fluid, C designates a concentration of said at least one element of interest in said fluid, and F designates a flow rate of said fluid through said ionic preconcentration cell;

said high surface area electrodes further comprise said ordinary surface area A approximately equal to an interrogation spot area of x-rays to which said preconcentration cell is to be exposed;

said ε is chosen to be below approximately 5% for said at least one element of interest;

said Φ is chosen to be below an electrochemical potential of said at least one element of interest and below an electrolysis potential of said fluid;

said F is chosen to exert no more than approximately .1 atm of pressure upon an upper x-ray transmission window of said ionic preconcentration cell in intimate contact with an upper surface of said upper high surface area electrode;

said n_f and said w_f are chosen with reference to said at least one element of interest; and

said w_i is chosen with reference to said fluid.

178. (previously presented) The optimization method of claim 177, wherein:

as a consequence of said optimizing, said central flow interelectrode gap comprises said predetermined interelectrode

gap width, d, with:

a minimum gap width selected from a minimum gap width group consisting of 2 mm, 1 mm, .5 mm, and .25 mm; and

a maximum gap width selected from a maximum gap width group consisting of 2 mm, 5 mm, and 10 mm.

179-190 (cancelled)

191. (previously presented) An ionic preconcentration cell apparatus for identifying and measuring concentrations of elements in fluids, comprising:

an upper high surface area electrode comprising a high specific surface area thereof;

a lower high surface area electrode comprising a high specific surface area thereof, substantially parallel to said upper high surface area electrode;

a central flow interelectrode gap separating said upper and lower high surface area electrodes by a predetermined interelectrode gap width;

fluid flow means for flowing a fluid through said central flow interelectrode gap; and

flow control means for controlling a flow rate of said fluid through said ionic preconcentration cell so as to maintain ε, which designates a predetermined percentage of at least one element of interest to be extracted from said fluid, below approximately 5% for said at least one element of interest.

192. (previously presented) The apparatus of claim 191, wherein said ε is maintained below an extraction percentage

selected from an extraction percentage group consisting of approximately 4%, 3%, 2%, and 1%.

193. (previously presented) The apparatus of claim 191, further comprising:

voltage application means for applying a voltage differential between said upper high surface area electrode and said lower high surface area electrode while said fluid is flowing through said central flow interelectrode gap; and

said flow control means for controlling said flow rate F of said fluid through said ionic preconcentration cell and maintaining said F at a substantially constant level so as to maintain said ε, which is specified by:

$$\varepsilon = \frac{\Gamma_{ie}}{\Gamma_{is}} = \frac{\sigma \Phi}{q d} \frac{w_i}{w_f} \frac{A}{n_f C F} \times 100\% ,$$

below approximately 5% for said at least one element of interest; wherein:

Γ_{ie} and Γ_{is} designate rates at which ions of said at least one element of interest are respectively extracted from said fluid by said cell and supplied to said cell by said fluid, σ designates a composite conductivity of said fluid, Φ designates a potential applied by said voltage application means across said electrodes, d designates said predetermined interelectrode gap width of said central flow interelectrode gap, $q = 1.60\text{x}10^{-19}$ Coulomb designates the unit charge, A designates an ordinary surface area covered by said electrodes, n_f designates a number density of said fluid, w_i and w_f designate atomic / molecular weights, respectively, of said at least one element of interest

and of said fluid, and C designates a concentration of said at least one element of interest in said fluid; and

for having said concentration C in a range where conductivity varies substantially linearly with concentration, with C in units of parts per billion, wherein σ is approximated by:

$$\sigma \approx 2 \times 10^{-9}\, C / \mathrm{Ohm-cm}\,.$$

194. (previously presented) The apparatus of claim 193, wherein said ε is maintained below an extraction percentage selected from an extraction percentage group consisting of approximately 4%, 3%, 2%, and 1%.

195. (previously presented) A method for identifying and measuring concentrations of elements in fluids, comprising the steps of:

flowing a fluid through a central flow interelectrode gap of an ionic preconcentration cell separating an upper high specific surface area electrode from a lower high specific surface area electrode of said ionic preconcentration cell by a predetermined interelectrode gap width;

applying a voltage differential between said upper high surface area electrode and said lower high surface area electrode while said fluid is flowing through said central flow interelectrode gap;

exposing said cell to x-rays;

deducing an identity, or measurement of concentration, of at least one element in said fluid based on a response of said preconcentration cell to said x-rays; and

controlling a flow rate of said fluid through said ionic preconcentration cell so as to maintain ε, which designates a predetermined percentage of at least one element of interest to be extracted from said fluid, below approximately 5% for said at least one element of interest.

196. (previously presented) The method of claim 195, further comprising the step of:

maintaining said ε below an extraction percentage selected from an extraction percentage group consisting of approximately 4%, 3%, 2%, and 1%.

197. (previously presented) The method of claim 195, said step of controlling said flow rate further comprising the step of:

controlling said flow rate F of said fluid through said ionic preconcentration cell and maintaining said F at a substantially constant level so as to maintain said ε, which is specified by:

$$\varepsilon = \frac{\Gamma_{ie}}{\Gamma_{is}} = \frac{\sigma\Phi}{qd}\frac{w_i}{w_f}\frac{A}{n_f CF}\times 100\%,$$

below approximately 5% for said at least one element of interest; wherein:

Γ_{ie} and Γ_{is} designate rates at which ions of said at least one element of interest are respectively extracted from said fluid by said cell and supplied to said cell by said fluid, σ designates a composite conductivity of said fluid, Φ designates said voltage differential applied across said electrodes, d designates said predetermined interelectrode gap width of said central flow interelectrode gap, $q = 1.60\text{x}10^{-19}$ Coulomb designates

the unit charge, A designates an ordinary surface area covered by said electrodes, n_f designates a number density of said fluid, w_i and w_f designate atomic / molecular weights, respectively, of said at least one element of interest and of said fluid, and C designates a concentration of said at least one element of interest in said fluid; and

having said concentration C in a range where conductivity varies substantially linearly with concentration, with C in units of parts per billion, wherein σ is approximated by:

$$\sigma \approx 2 \times 10^{-9}\, C / \mathrm{Ohm} - \mathrm{cm}\ .$$

198. (previously presented) The method of claim 197, further comprising the step of:

maintaining said ε below an extraction percentage selected from an extraction percentage group consisting of approximately 4%, 3%, 2%, and 1%.

199. (previously presented) An ionic preconcentration cell apparatus for identifying and measuring concentrations of elements in fluids, comprising:

an upper high surface area electrode comprising a high specific surface area thereof;

a lower high surface area electrode comprising a high specific surface area thereof, substantially parallel to said upper high surface area electrode;

a central flow interelectrode gap separating said upper and lower high surface area electrodes by a predetermined interelectrode gap width;

fluid flow means for flowing a fluid through said central

flow interelectrode gap; and

time control means for controlling how long said fluid flows through said ionic preconcentration cell based on setting an impurity concentration *C*, in a range where conductivity varies substantially linearly with concentration, to a predetermined desired concentration detection level and flowing said fluid for a time *t* given by:

$$t \propto \frac{S\ell}{\sigma} \propto \frac{S\ell}{C};$$ wherein:

S designates a sensitivity of x-ray detection equipment to be used for said detecting and measuring;

ℓ designates a thickness of said upper high surface area electrode; and

σ designates a composite conductivity of said fluid.

200. (previously presented) A method for identifying and measuring concentrations of elements in fluids, comprising the steps of:

flowing a fluid through a central flow interelectrode gap of an ionic preconcentration cell separating an upper high specific surface area electrode from a lower high specific surface area electrode of said ionic preconcentration cell by a predetermined interelectrode gap width;

applying a voltage differential between said upper high surface area electrode and said lower high surface area electrode while said fluid is flowing through said central flow interelectrode gap;

exposing said cell to x-rays;

deducing an identity, or measurement of concentration, of at least one element in said fluid based on a response of said preconcentration cell to said x-rays;

setting an impurity concentration C, in a range where conductivity varies substantially linearly with concentration, to a predetermined desired concentration detection level; and

controlling how long said fluid flows through said ionic preconcentration cell by flowing said fluid for a time t given by:

$t \propto \frac{S\ell}{\sigma} \propto \frac{S\ell}{C}$, wherein:

S designates a sensitivity of x-ray detection equipment to be used for said identifying and measuring;

ℓ designates a thickness of said upper high surface area electrode; and

σ designates a composite conductivity of said fluid.